Thresholds of Disturbance:

Land Management Effects on Vegetation and Nitrogen Dynamics

CS-1114E-00

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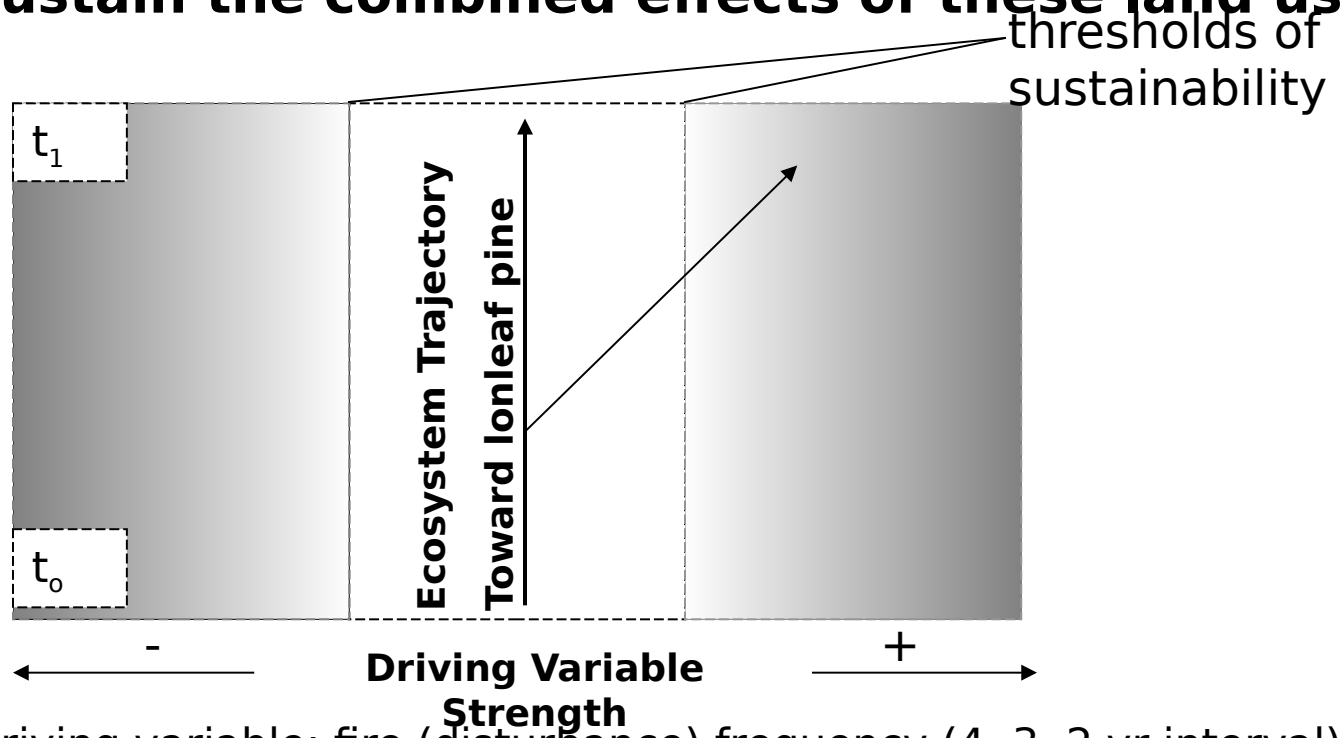
Project Status

Research Objective

Objective: To evaluate the ecological effects of military training and forest management for longleaf pine at Ft. Benning, to determine if there are thresholds beyond which upland ecosystems cannot sustain the combined effects of these land uses.

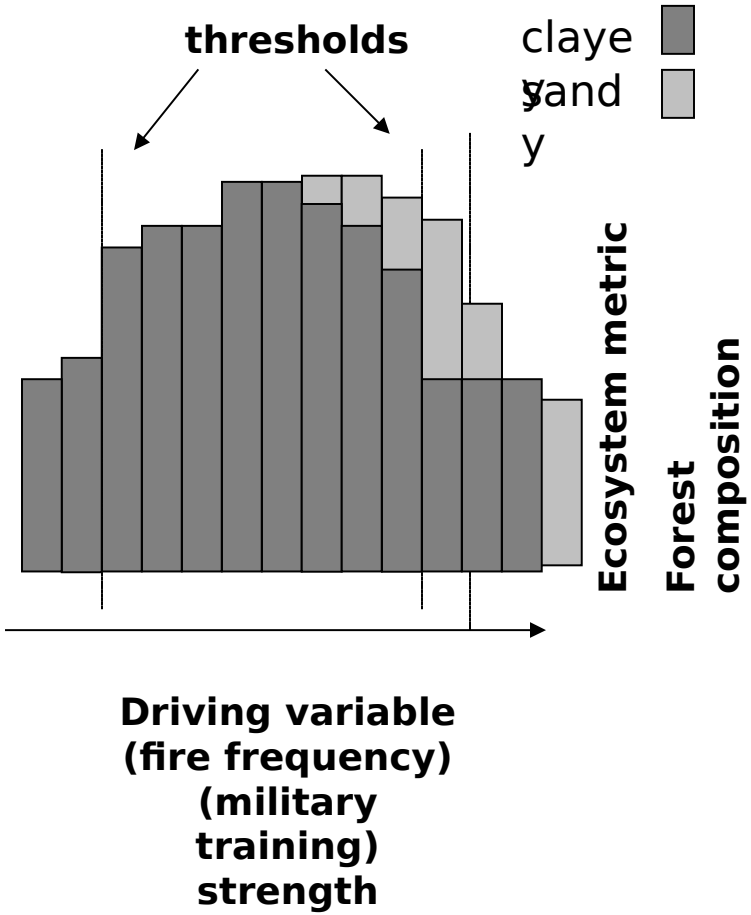


Driving variable: fire (disturbance) frequency (4, 3, 2 yr interval)

Driving variable: military training (disturbance) intensity (lighter vs. heavier)

Research Hypothesis

Underlying soil type (texture) partly determines forest composition and dynamics, modifies the effects of military training and forest management, and influences the disturbance threshold for sustainability



Approach

Experimental

- **sites with sandy vs. clayey soil and lighter vs. heavier military training**

- **combinations of forest management for longleaf pine: (2 yr vs. 4 yr burn cycle [applied treatments])**

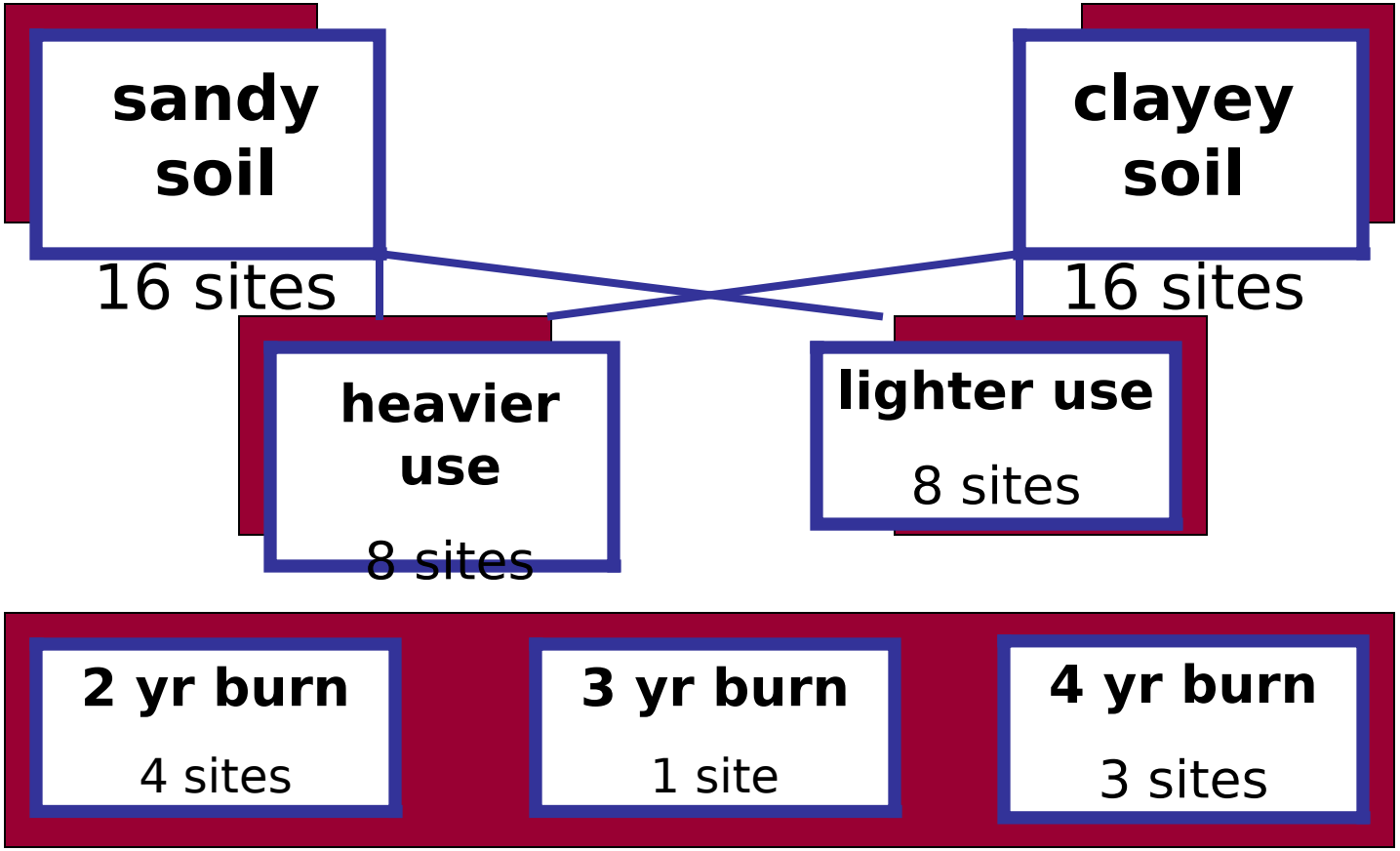
- **a range of time since thinning over sites**

Metrics - biogeochemical cycling (N,C), vegetation composition and structure; understory trajectory

Duration

- **5 yr study (1/00 – 12/04)**
- **two, 2yr fire cycles and one, 4yr fire interval**

Modified Research Design



Due to accidental burn (1/03), a 3-yr burn treatment was added by converting one 4-yr burn site in each soil texture and military use category (total = four 3-yr burn sites), but these sites not burned due to rain.

Timeline

Spring 00 – all sites prescribe-burned; 32 sites chosen

Summer- Fall 00 – baseline vegetation, soil, disturbance surveys

Spring-Summer 01 – establish field experiments, monitoring protocols

Summer-Fall 01 – monitor 2nd yr response to fire in all sites

Winter 01-Spring 02 – 2 yr prescribe fire (16 sites)

Summer-Fall 02 – monitor 1st (2 yr burns) or 3rd (4 yr burns) yr response to fire

Winter 02-Spring 03 – accidental fire, 1 site

Spring-Summer03 – monitor 2nd (2 yr burns) or 4th yr (4 yr burns) response to fire

Metrics

- biogeochemical cycling
  - litter decomposition (longleaf, deciduous, fine root)
  - soil mineralization (field and laboratory); respiration
  - available NO_3/NH_4, cations; bulk density
  - A layer depth; organic layer mass
- environment
  - soil, air temperature
  - soil moisture
- vegetation response
  - fine root production, litter and seed inputs
  - ground layer vegetation
  - ground layer, legume biomass
  - h (tree rings)

Plans (2004)

Winter-Spring 04 – burn (all sites)

Spring-Summer 04 – monitor 1st season after 2, 2yr or 1, 4yr burn cycle

abbreviated sampling

metrics: organic layer mass, N; soil N; ground vegetation

Fall-Dec 04 –

place data in repository;

analyze results;

prepare reports;

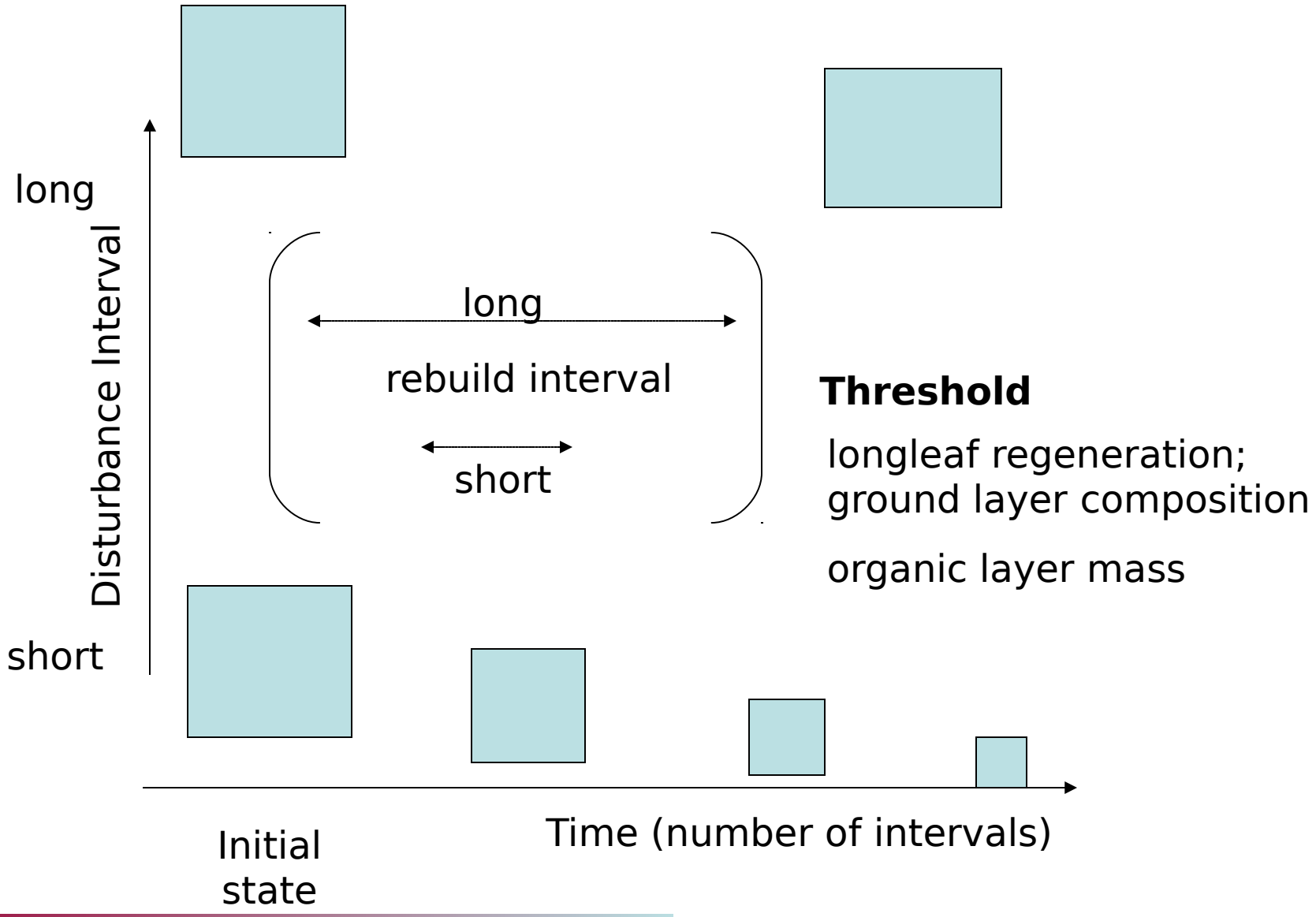
clean up field, Benning lab;

Technology Transfer to Fort Benning

27 June 2003 meeting between Pete Swiderek Natural Resources Branch Chief, Robert Larimore, Land Management Branch Chief, and John Dilustro in response to "The SEMP TAC recommendation that the installation review the project's approach and its relevancy to the installation's land management goals and objectives.....Thus, we have asked that you (SREL) meet with the installation staff and ensure that the project has relevancy to their needs." SREL will provide the following items, which were determined to be useful products to Ft. Benning either now or in the future:

1. **Provide field plots for incorporation into long term monitoring plan**
2. **Provide results from biogeochemical metrics and fire data in mixed stands that should be useful for management consideration over the short term (50 years).**
3. **Provide N cycling information/models that may be useful as ecological indicators**
4. **Provide results of ground layer response to fire that will support Recovery Plan groundcover requirements**

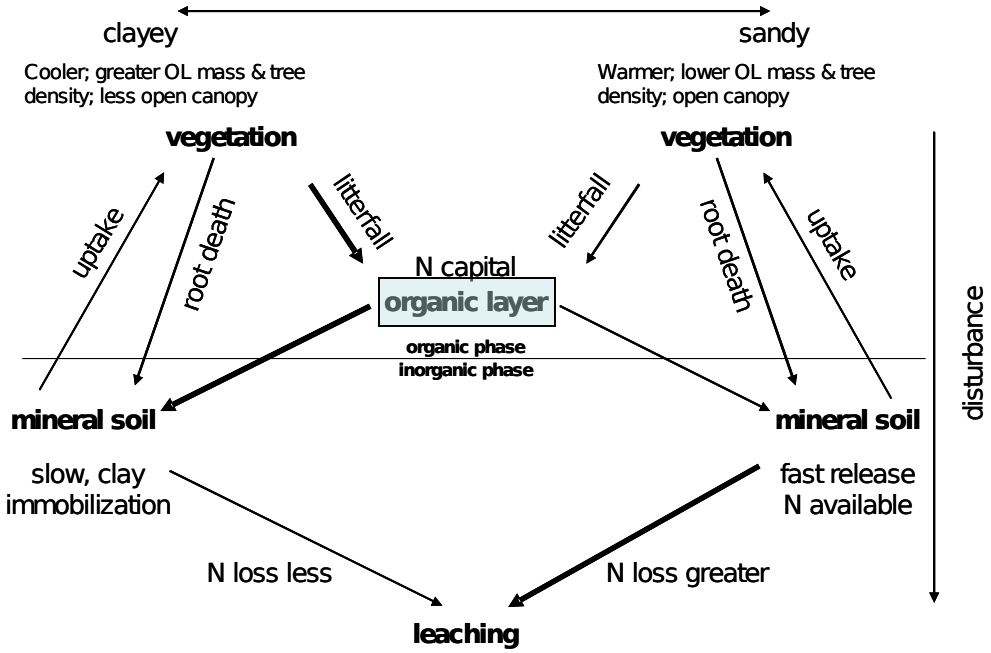
Discoveries



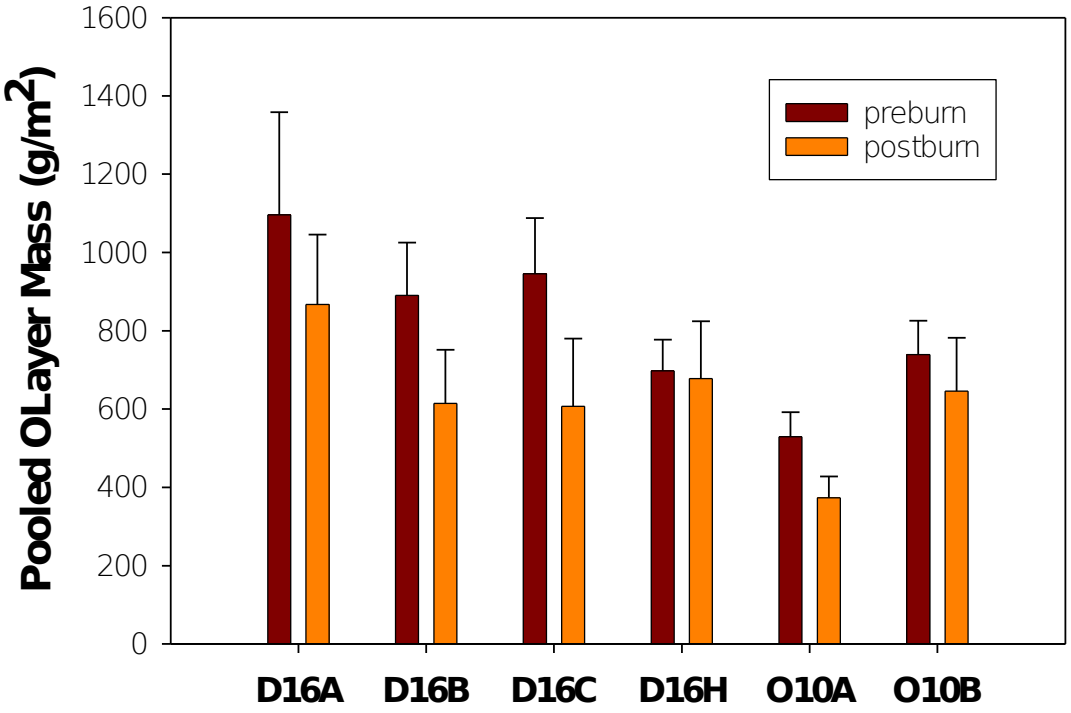
Discoveries

	LC	HC	LS	HS
O.L. Mass (g/m^2)	**1165.2_a** (100.5)	931.0_{ab} (74.6)	922.8_{ab}(96.7)	807.7_b (100.6)
O.L. % Nitrogen	0.75_a (0.03)	0.65_a (0.02)	0.73_a (0.02)	0.70_a (0.02)
Nitrogen Pool (g N/m^2)	**8.68_a** (0.93)	6.02_b (0.47)	6.92_{ab} (0.75)	6.07_{ab} (0.96)

Organic layer integrates N transformations. OL mass before prescribed fire is greatest in clayey sites with lighter (no tracked vehicle) military training



2yr interval fire removed 64 – 98 % of the organic layer mass



Information gap: Do repeated fires lead to ever-decreasing organic layer, or does the organic layer regenerate between burns at 2 or 4 yr intervals?

- sample the organic layer before and after the fall-winter burns (2nd 2yr cycle or 1 4yr cycle)

Slide

Discoveries

loblolly pine

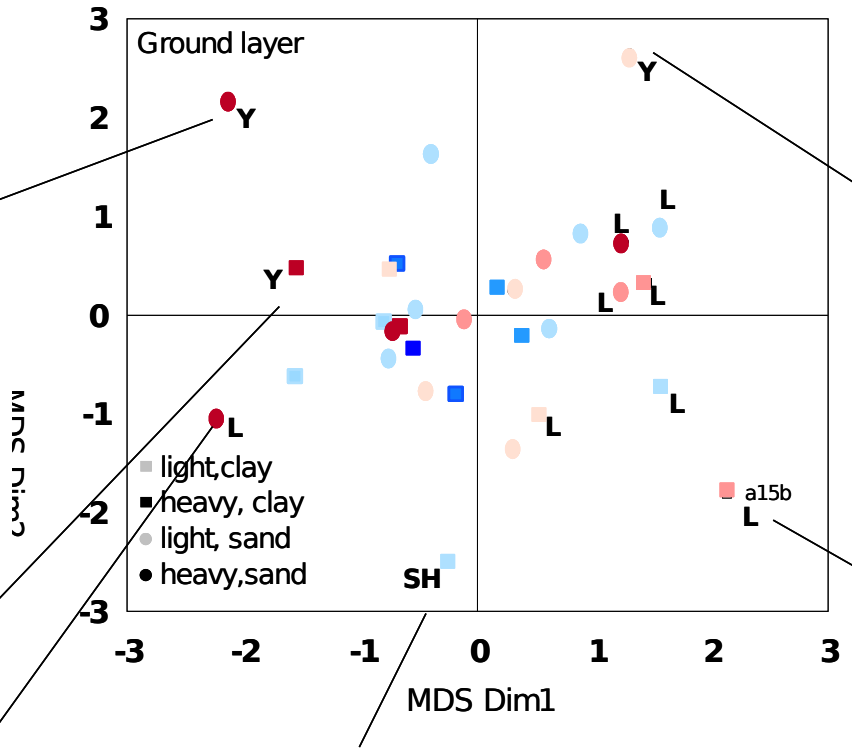
sweet gum, oaks, sassafras

loblolly pine

sweet gum

longleaf pine

sweet gum, *Ilex glabra*



loblolly pine

Heterotheca graminifolia, sumac, poison ivy, oak seedlings

longleaf pine

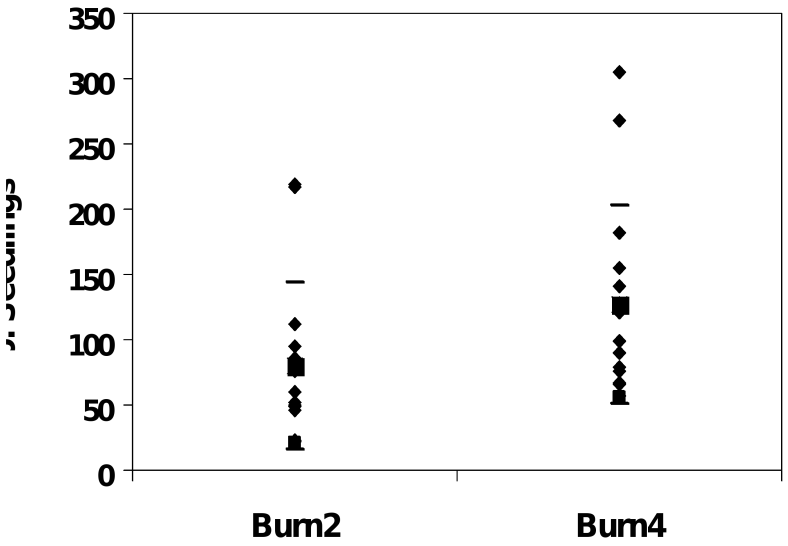
grasses, bracken

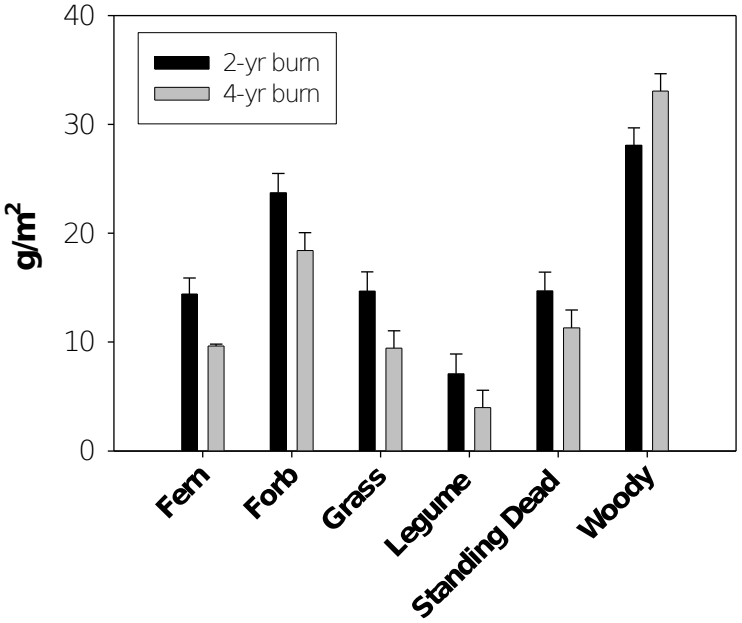
shortleaf pine, hardwoods

bracken fern, *Smilax* spp, sweet gum, loblolly, black gum

- sites with unique species composition tend to have burned ≥ 4 times since 1980 or are in heavier military use compartments
- these sites are dominated by open-site, early successional, or fire-tolerant species.

There were more seedlings/sprouts in 4-yr burn sites than in 2-yr burn sites in 2002.

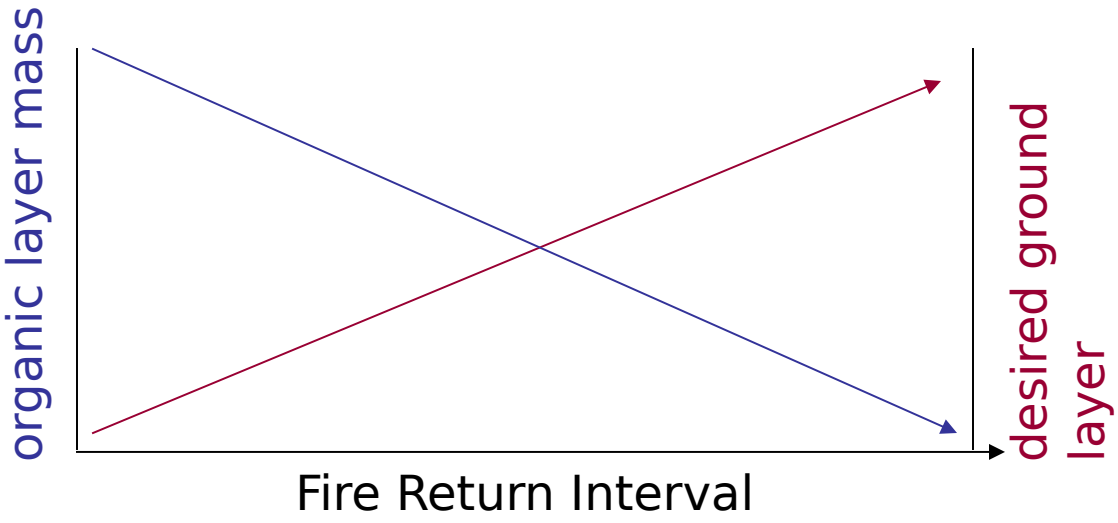




- fire causes a decrease in biomass of woody species, but an increase in fern, forb, grass, and legume biomass.

Information gap: Do repeated fires lead to a greater increases in fire-tolerant grasses and legumes, as required by new red cockaded woodpecker guidelines?

Is there a shift in ground layer composition with a 2yr vs 4yr burning interval?



? Thresholds associated with 2-yr, 4-yr return intervals

? Are combined effects

- synergistic

- antagonistic

- neutral

Management Implications

1. **Thresholds of fire frequency and repetition effects on organic layer and groundlayer composition can identify management practices that encourage desirable groundlayer species while maintaining forest productivity**
2. **Retaining SREL field plots as monitoring plots would allow management practices to be evaluated over a range of upland forest conditions and natural gradients**
3. **SREL experimental results that identify which sites will naturally regenerate longleaf, and longleaf 'regeneration models' can provide information for management decisions such as whether or not to plant**

Publications

Published

Dilustro J.J., Collins B., L. Duncan and R. Sharitz. 2002. Soil Texture, land use intensity, and vegetation of Ft Benning upland forest sites. Journal of the Torrey Botanical Society 129(4):280-297

Collins, B. 2002. Symposium: regional partnerships for ecosystem research and management. SE Biology 49(4):372-378.

Submitted

Dilustro, J.J., B. Collins, and L. Duncan. Soil Nitrogen Cycling and Availability in Mixed Pine Forests at Fort Benning, GA. In revisions.

In prep

Dilustro, J.J., B. Collins, and L. Duncan. Short-term impacts of prescribed burning on forest floor and soil nitrogen and carbon in mixed pine uplands. Submission 10/03

Dilustro, J.J., B. Collins, and L. Duncan. Longer-term impacts of prescribed burning in mixed pine upland forests. Submission 11/03

Planned

Collins, B., J. J. Dilustro, and L. Duncan. Ecological thresholds associated with landuse: applications for land management

Collins, B., J. J. Dilustro, and L. Duncan. Land use effects on vegetation trajectories at Fort Benning

Dilustro, J.J., B. Collins, and L. Duncan. Decomposition of litter and roots in mixed pine upland forests on varying soil textures.